REMARKS

This response is being filed in response to an Office Action dated September 1, 2004. Claims 1, 2 and 4-7 are pending in this application, stand rejected, and have been maintained unchanged. The Examiner has withdrawn the prior rejections and omposed a new prior art rejection. Applicant respectfully requests reconsideration of the present application in light of the following remarks.

Brief Remarks regarding the Invention

Prior to addressing the rejections discussed in the Office Action, Applicants take this opportunity to set forth the following brief remarks in connection with their invention, which is directed to a cleaning medium for a magnetic recording apparatus.

The technical object of the present invention is to provide a cleaning medium, such as a cleaning tape, for a head of a magnetic recording apparatus. Cleaning media in accordance with the invention have high cleaning power, but do not scratch the magnetic head, i.e., they provide reduced head abrasion.

The invention removes debris on the surface of a magnetic head as it runs a cleaning layer in sliding contact with the magnetic head. Accordingly, the cleaning layer of the invention is advantageously relatively soft to prevent scratching and includes protrusions on the surface of the cleaning layer to provide cleaning capabilities.

In order to achieve the aforementioned technical objectives, Applicants developed a cleaning medium comprising a nonmagnetic support, having a lower coating layer and a cleaning layer over the lower coating layer. The cleaning layer contains at least a ferromagnetic inorganic powder and a binder. In use, the cleaning layer runs in sliding contact with a head to remove

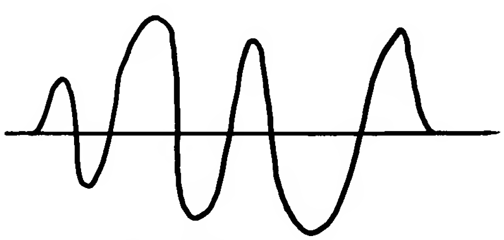
debris from the head. The cleaning layer preferably has a thickness from about 0.05 to 1.0 μm, the thickness of the lower coating layer is preferably from about 0.2 to 5.0 μm, the thickness of the support is preferably from about 2.0 to 10 μm, and the total thickness of the cleaning medium, such as a cleaning tape, is preferably from about 4.0 to 15 μm. The cleaning layer is preferably produced by one of the various methods disclosed in the specification. For example, a resin roll and a metal roll can be used in a calendaring step. The resulting cleaning layer is preferably relatively soft and comprises cleaning protrusions.

An important aspect of the cleaning medium is the presence of 5 to 80 protrusions with a height of 35 to 100 nm per 900 μm^2 on the surface of the cleaning layer. It is also advantageous that the cleaning layer contains fatty acid amides, fatty acids and fatty acid esters to optimize the frictional coefficient with the head. Thus, at least the presence of these protrusions of specified height on the surface of the cleaning layer and the lubricant comprising fatty acid amides, fatty acids <u>and</u> fatty acid esters help distinguish the invention from an ordinary cleaning medium.

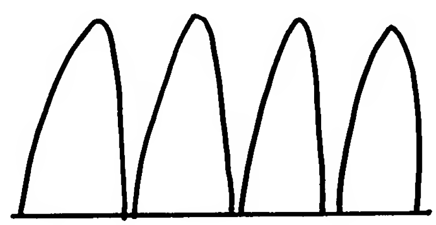
<u>The Rejections Under 35 U.S.C. § 102(b)</u>

Claims 1 and 7 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,124,030 to Suzuki et al. ("Suzuki"). The Examiner asserts that Suzuki teaches all the elements of claims 1 and 7. The Examiner admits that Suzuki fails to teach the "protrusion height" of the surface cleaning layer as required in the claims. However, the Examiner asserts that Suzuki teaches an average "surface roughness" value (Ra) of between 1.0 and 7.0 nm. According to the Examiner, the protrusion height is inherent in the surface roughness Ra value. Applicants respectfully traverse this rejection.

Surface roughness value (Ra) represents the central line average surface roughness. It is an arithmetic mean of both protrusions and depressions. For example, a surface having smaller protrusions but deeper depressions can have the same Ra as a surface having higher protrusions and no depressions. Fig. 1 below (not precisely to scale) shows that two surfaces could have the same Ra, with one having twice the protrusion height of the other. Accordingly, a limitless distribution of protrusion heights can exist for the same Ra value. However, what is clear is that the Ra value does <u>not</u> dictate the protrusion height of the surface. A copy of JIS "Japanese Industrial Standard" on "Surface roughness – Definitions and designation JIS B 0601" is enclosed for the Examiner's reference. Applicants respectfully draw the Examiner's attention to page 5 of the document, in which the "Definition of Ra" and the "Determination of Ra" are provided.



Ra = 3 nm



Ra = 3 nm

FIG. 1

Moreover, Suzuki fails to teach or suggest the combination of all three claimed lubricant materials: "fatty acid amide, fatty acid and fatty acid ester". Rather, Suzuki names them as possible additives, dispersed in a list containing over 30 different potential additives. Suzuki

does not teach or suggest specifically selecting fatty acid amide, fatty acid and fatty acid ester from the list and combining these materials in the cleaning layer.

Therefore, Applicants respectfully assert that Suzuki fails to teach or suggest the protrusion height and the combination of fatty acid amide, fatty acid and fatty acid ester as required in the claims, and accordingly, fails to anticipate claims 1 and 7.

The Rejections Under 35 U.S.C. § 103

Claims 2 and 4-6 were rejected under 35 U.S.C. § 103(a) as obvious over Suzuki in view of U.S. Patent No. 5,747,157 to Hashimoto et al. ("Hashimoto"). Applicants respectfully assert that Hashimoto fails to remedy the inadequacies of Suzuki, because Hashimoto also fails to teach or suggest the protrusion height and the fatty acid additives specified in independent claim 1. Claims 2 and 4-6 all depend from claim 1, and accordingly, Suzuki in view of Hashimoto fails to render claims 1 and 4-6 unpatentable.

CONCLUSION

Applicants respectfully submit that all outstanding rejections have been addressed and are now either overcome or moot. Applicants further submit that all claims pending in this application are patentable over the prior art. Favorable reconsideration and withdrawal of those rejections and objections is respectfully requested.

Favorable consideration and prompt allowance of this application is respectfully requested. In the event that there are any questions, or should additional information be required, please do not hesitate to contact Applicants' attorney at the number listed below.

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JIS

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JAPANESE INDUSTRIAL STANDARD

Surface roughness— Definitions and designation

JIS B 0601-1994

Translated and Published

by

Japanese Standards Association

Printed in Japan

15 S

In the event of any doubt arising,
the original Standard in Japanese is to be final authority

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association.

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UDC 003. 62: 621. 7. 015

JAPANESE INDUSTRIAL STANDARD

JIS B 0601-1994

Surface roughness — Definitions and designation

1. Scope This Japanese Industrial Standard specifies the definitions and designation of the arithmetical mean roughness, maximum height, ten-point mean roughness, mean spacing of profile irregularities, mean spacing of local peaks of the profile and profile bearing length ratio, which are the parameters expressing the surface roughness of industrial products.

Remarks: The International standards corresponding to this Standard are shown below:

ISO 468-1982 Surface roughness — Parameters, their values and general rules for specifying requirements

ISO 3274-1975 Instruments for the measurement of surface roughness by the profile method — Contact (stylus) instruments of consecutive profile transformation — Contact profile meters, system M

ISO 4287/1-1984 Surface roughness — Terminology Part 1: Surface and its parameters

ISO 4287/2-1984 Surface roughness — Terminology Part 2: Measurement of surface roughness parameters

ISO 4288-1985 Rules and procedures for the measurement of surface roughness using stylus instruments

2. Definitions and symbols For the main terms used in this Standard, the following definitions apply.

The symbols for them are given in parentheses following each term.

(1) surface roughness Each arithmetical mean value of arithmetical mean roughness (R_a), maximum height (R_y), ten-point mean roughness (R_z), mean spacing of profile irregularities (S_m), mean spacing of local peaks of the profile (S) and profile bearing length ratio (t_p) which are the parameters expressing the surface roughness at each part sampled randomly from the surface of an object (hereafter referred to as "objective surface").

Remarks 1. Generally in an objective surface, surface roughness on individual positions is not uniform, and usually presents considerably large dispersion. Therefore, in assessing the surface roughness of the objective surface, it is necessary to determine the measuring positions and numbers thereof so that the population mean can be assumed effectively.

2. According to the objects of measurement, an assessed value at one point on the objective surface may represent the surface roughness of the entire surface.

(2) profile curve A contour appears on a cut end, when a surface to be measured has been cut with a plane which is perpendicular to that surface.

Remarks: In this cutting, if the surface has generally the directionality, it shall be cut in perpendicular in that direction.

(3) roughness curve A curve which has been cut off any longer surface waviness component than a prescribed wavelength from the profile curve by means of phase compensation type high-pass filter.

(4) cut-off value of roughness curve (λ_c) A wavelength corresponding to the frequency which makes the gain of phase compensation type high-pass filter 50 % (hereafter referred to as "cut-off value").

(5) reference length of roughness curve (l) A length of a part made by sampling the length of cut-off value from the roughness curve (hereafter referred to as "reference length").

(6) evaluation length of roughness curve (l_n) A length including one or more reference length used for evaluation of surface roughness (hereafter referred to as "evaluation length"). The standard value of evaluation length shall be five times the reference length.

(7) waviness of filtered wave A curve made by cutting off the component of surface roughness shorter than a given wavelength from the profile curve by means of phase compensation type low-pass filter [see Fig. 1 (a)].

(8) mean line of roughness curve (m) A line made by converting the waviness of filtered wave at the part sampled from the profile curve to the straight line (hereafter referred to as "mean line") [see Fig. 1 (a)].

(9) profile peak An outwardly directed entity of profile surrounded by the roughness curve and the mean line connecting two adjacent points of the intersection made when cutting the roughness curve with the mean line [see Fig. 1 (b)].

Remarks: In the roughness curve, the outwardly directed portion from the mean line at the beginning and the end of the reference length should be considered as a profile peak.

(10) profile valley An inwardly directed portion of space surrounded by the roughness curve and the mean line connecting two adjacent points of intersection made when cutting the roughness curve with the mean line [see Fig. 1 (b)].

Remarks: In the roughness curve, the inwardly directed portion from the mean line at the beginning and end of the reference length should be considered as a valley.

(11) top of profile peak A point of the highest altitude in the profile peak of roughness curve [see Fig. 1 (b)].

(12) bottom of profile valley A point of the lowest altitude in the profile valley of roughness curve [see Fig. 1 (b)].

(13) <u>top of profile peak line</u> Of the reference lengths sampled from the roughness curve, the line parallel to the mean line passing through the highest top of profile peak [see Fig. 1 (b)].

(14) <u>bottom of profile valley line</u> Of the reference lengths sampled from the roughness curve, the line parallel to the mean line passing through the lowest bottom of profile valley [see Fig. 1 (b)].

(15) <u>cutting level</u> A vertical distance between the top of profile peak line and the line parallel to the top of profile peak line intersecting the roughness curve.

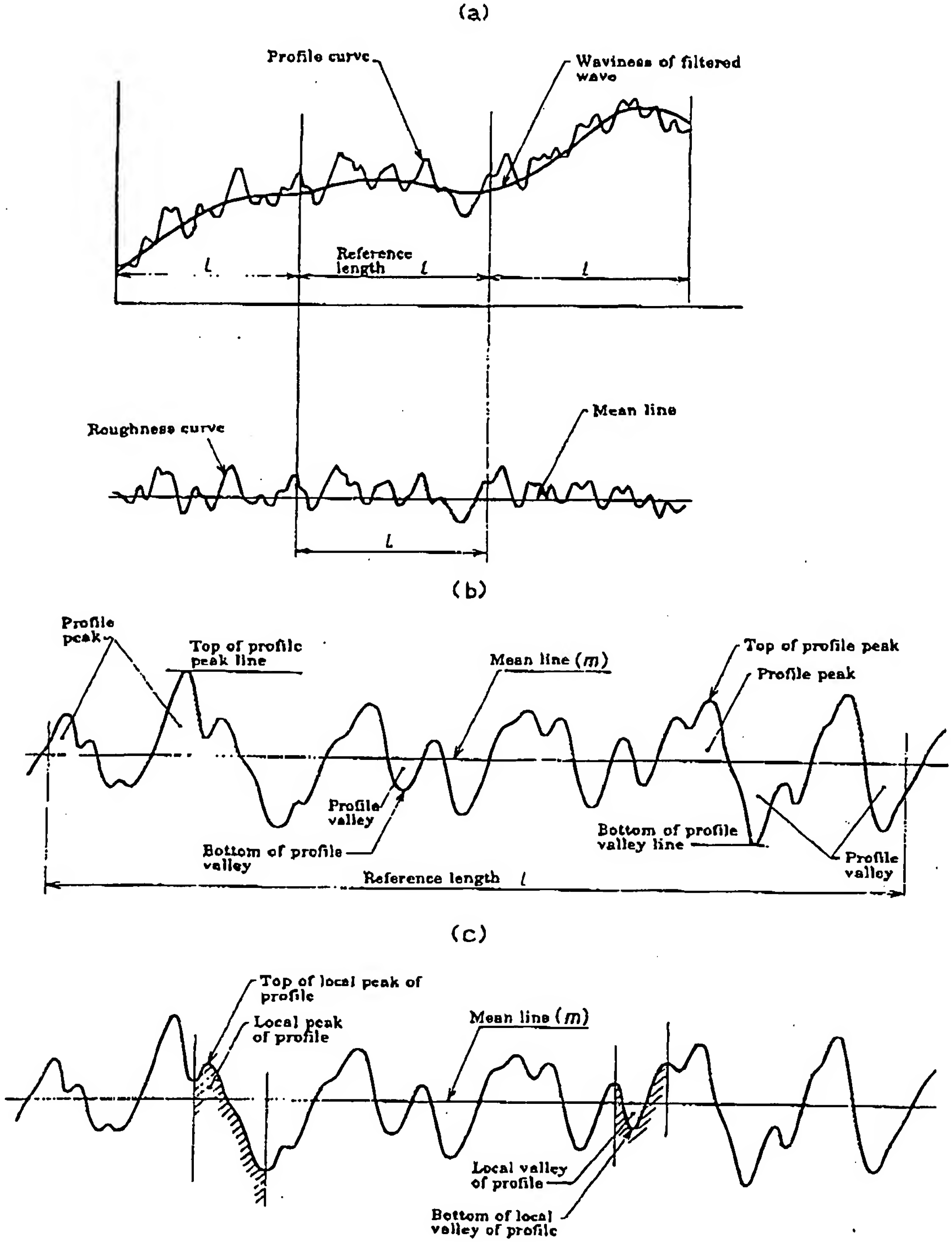
(16) <u>local peak of profile</u> A part of entity between two adjacent minima of the roughness curve [see Fig. 1 (c)].

(17) <u>local valley of profile</u> A part of space between two adjacent maxima of the roughness curve [see Fig. 1 (c)].

(18) <u>top of local peak of profile</u> A point of the highest altitude in the local peak of profile [see Fig. 1 (c)].

(19) <u>bottom of local valley of profile</u> A point of the lowest altitude in the local valley of profile [see Fig. 1 (c)].

Fig. 1. Explanation on profile curve, roughness curve, mean line, reference length, profile peak, profile valley, local peak of profile and local valley of profile



3. Definition and designation of arithmetical mean roughness (R_a)

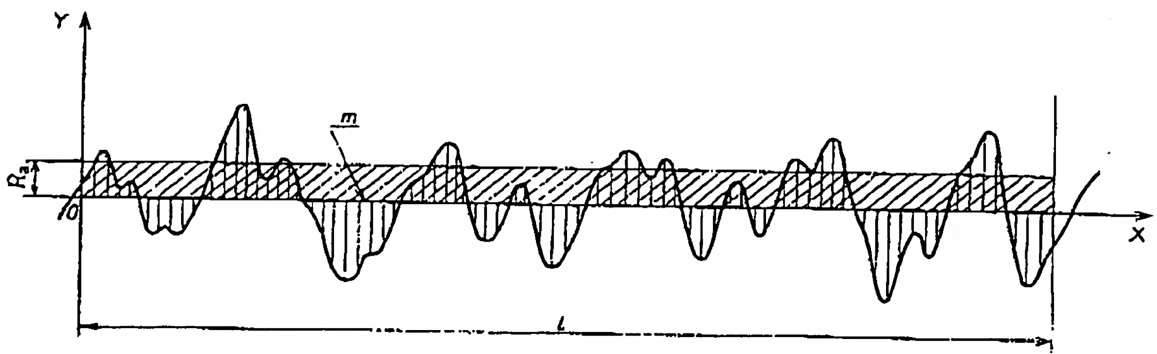
3.1 Definition of R_a

3.1.1 Determination of R_a R_a means the value obtained by the following formula and expressed in micrometer (μm) when sampling only the reference length from the roughness curve in the direction of mean line, taking X-axis in the direction of mean line and Y-axis in the direction of longitudinal magnification of this sampled part and the roughness curve is expressed by $y = f(x)$:

$$R_a = \frac{1}{l} \int_0^l |f(x)| dx$$

where, l : reference length

Fig. 2. Determination of R_a



3.1.2 Cut-off values The cut-off values when obtaining R_a shall generally be chosen from the following six kinds:

0.08, 0.25, 0.8, 2.5, 8, 25 Unit: mm

3.1.3 Standard values of cut-off values The standard values of the cut-off value and the evaluation length corresponding to the range of R_a, when obtaining R_a, shall be in accordance with the divisions in Table 1.

Table 1. Standard values of cut-off value and evaluation length in determining R_a

Range of R_a (μm)		Cut-off value λ_c	Evaluation length l_n
Exceeding	Max.	(mm)	(mm)
(0.006)	0.02	0.08	0.4
0.02	0.1	0.25	1.25
0.1	2.0	0.8	4
2.0	10.0	2.5	12.5
10.0	80.0	8	40

The value within ( ) is given for informative reference.

Remarks: R_a shall be determined by firstly designating the cut-off values. In carrying out the designation or instruction of the surface roughness, as it is inconvenient to designate that on all such occasions, values given in Table 1 should be used generally.

3.2 Expression of R_a

3.2.1 Designation of R_a The designation of R_a shall be as follows:

Arithmetical mean roughness ______ μm, Cut-off value ______ mm, Evaluation length ______ mm

or

______ μmR_a, λ_c ______ mm, l_n ______ mm

Remarks 1. In the case where the value of R_a obtained by using the standard value of the cut-off value given in Table 1 is in the range shown in Table 1, the designation of the cut-off value may be omitted.

2. In the case where the evaluation length is five times the cut-off value that is the standard value of evaluation length in Table 1 is used, the designation of the evaluation length may be omitted.

3.2.2 Preferred number series of R_a When the surface roughness is designated by R_a, the preferred number series of Table 2 should be used generally.

Table 2. Preferred number series of Ra

Unit: μm

0.008				
0.010				
0.012	0.125	1.25	**12.5**	125
0.016	0.160	**1.60**	16.0	160
0.020	**0.20**	2.0	20	**200**
0.025	0.25	2.5	**25**	250
0.032	0.32	**3.2**	32	320
0.040	**0.40**	4.0	40	**400**
0.050	0.50	5.0	**50**	
0.063	0.63	**6.3**	63	
0.080	**0.80**	8.0	80	
0.100	1.00	10.0	**100**	

Remarks: It is preferable to use the preferred number series of common ratio of 2 shown with thick figures.

3.2.3 Sectional designation of R_a If it is required to designate R_a in a certain section, numerical values corresponding to the upper limit (that of the larger designation value) and lower limit (that of the smaller designation value) shall be stated additionally by selecting from Table 2.

Example 1. In the case where standard values of cut-off values for upper limit and lower limit are equal A sectional designation when the upper limit of 6.3 μmR_a and the lower limit of 3.2 μmR_a shall be designated as (6.3 to 3.2) μmR_a. In this case, 2.5 mm shall be used for the cut-off value.

Example 2. In the case where standard values of cut-off values for upper limit and lower limit are different A sectional designation when the upper limit of 12.5 μmR_a and the lower limit of 3.2 μmR_a shall be designated as (12.5 to 3.2) μmR_a. In this case, it means that the value of R_a measured by a cut-off value of 8 mm is 12.5 μmR_a or under, and that the value of R_a measured by a cut-off value of 2.5 mm is 3.2 μmR_a or over.

Remarks 1. In the case where it is required to equalize the cut-off values corresponding to the upper and lower limits, or in the case where cut-off values other than standard values of Table 1 are to be used, the cut-off values shall be appended. In Example 2., when the cut-off value corresponding to the upper and lower limits is taken as 8 mm, it shall be designated as (12.5 to 3.2) μmR_a, λ_c 8 mm.

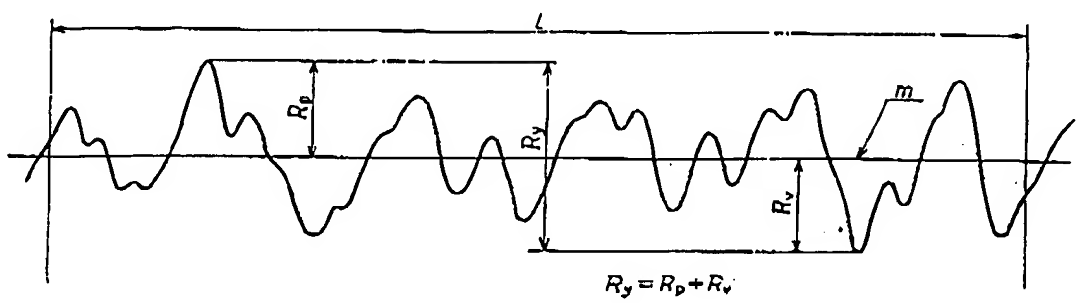
2. R_a of the upper and lower limits mentioned here shall be the arithmetical mean values of R_a at several points sampled randomly from the designated surface, but shall not be the maximum value of individual R_a.

4. Definition and designation of maximum height (R_y)

4.1 Definition of R_y

4.1.1 Determination of R_y R_y shall be that only the reference length is sampled from the roughness curve in the direction of mean line, the distance between the top of profile peak line and the bottom of profile valley line on this sampled portion is measured in the longitudinal magnification direction of roughness curve and the obtained value is expressed in micrometer (μm) (see Fig. 3).

Fig. 3. Determination of R_y



Remarks: In the determination of the maximum height (R_y), a length corresponding to the reference length shall be sampled from the part which is free from extraordinary high peak and deep valley considered as flaws.

4.1.2 Reference length In the determination of R_y, reference lengths shall generally be chosen from the following six kinds:

0.08, 0.25, 0.8, 2.5, 8, 25 Unit: mm

4.1.3 Standard values for reference lengths The standard values for reference lengths and evaluation lengths corresponding to the range of R_y, when determining R_y, should conform to the division of Table 3 generally.

Table 3. Standard values for reference lengths and evaluation lengths in determination of R_y

Range of R_y (µm)		Reference length l (mm)	Evaluation length l_n (mm)
Exceeding	Max.		
(0.025)	0.10	0.08	0.4
0.10	0.50	0.25	1.25
0.50	10.0	0.8	4
10.0	50.0	2.5	12.5
50.0	200.0	8	40

The value within ( ) is given for informative reference.

Remarks: R_y shall be determined upon designation of the reference length at first, however, in indicating and designating the surface roughness, because it is inconvenient to designate that on all such occasions, values given in Table 3 should be used generally.

4.2 Expression of R_y

4.2.1 Designation of R_y R_y shall be designated as follows:

Maximum height ______ µm, Reference length ______ mm, Evaluation length ______ mm

or

______ µmR_y, l ______ mm, l_n ______ mm

Remarks 1. In the case where the maximum-height value which has been obtained using the standard value of the reference length given in Table 3 lies within the range given in Table 3, the designation of the reference length may be omitted.

2. In the case where the evaluation length uses five times the reference length, namely the standard value of evaluation length shown in Table 3, the designation of evaluation length may be omitted.

4.2.2 Preferred number series of R_y In designating the surface roughness by R_y, the preferred number series of Table 4 should be used generally.

Table 4. Preferred number series of R_y

Unit: μm

	0.125	1.25	**12.5**	125	1250
	0.160	**1.60**	16.0	160	**1600**
	0.20	2.0	20	**200**	
0.025	0.25	2.5	**25**	250	
0.032	0.32	**3.2**	32	320	
0.040	**0.40**	4.0	40	**400**	
0.050	0.50	5.0	**50**	500	
0.063	0.63	**6.3**	63	630	
0.080	**0.80**	8.0	80	**800**	
0.100	1.00	10.0	**100**	1000	

Remarks: It is recommended to use the number series of common ratio of 2 shown with thick figures.

4.2.3 Sectional designation for R_y If it is required to designate R_y in a certain section, numerical values corresponding to the upper limit (the larger value of the designated value) and the lower limit (the smaller value of the designated value) of that section shall be selected from Table 4 and be stated together.

Example 1. If the standard values for reference lengths of upper and lower limits are equal The sectional designation for the upper limit of 6.3 μmR_y and lower limit of 1.60 μmR_y shall be designated as (6.3 to 1.60) μmR_y. In this case, 0.8 mm shall be used for the reference length.

Example 2. If the standard values for reference lengths of upper and lower limits are different The sectional designation for the upper limit of 12.5 μmR_y and lower limit of 1.60 μmR_y shall be designated as (12.5 to 1.60) μmR_y. In this case, it means that the value of R_y measured using a reference length of 2.5 mm is 12.5 μmR_y or under, and that the value of R_y measured using a reference length of 0.8 mm is 1.60 μmR_y or over.

Remarks 1. In the case where reference lengths corresponding to the upper and lower limits are required to be equal, or when any reference length other than the standard value of Table 3 is to be used, the reference length shall be stated together. In Example 2., when the reference length corresponding to the upper and lower limits is selected as 2.5 mm, it shall be designated as (12.5 to 1.60) μmR_y, l 2.5 mm.

2. R_y of the upper and lower limits mentioned here shall be an arithmetical mean value of R_y at several places which have been sampled randomly from the designated surface, but shall not be the maximum value of individual R_y.

5. Definition and designation of ten-point mean roughness (R_z)

5.1 Definition of R_z

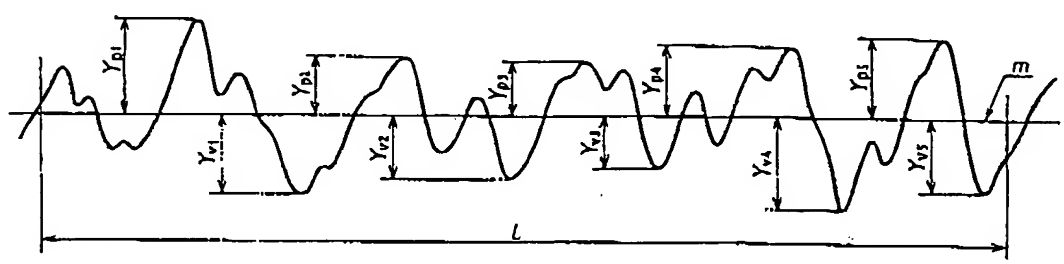
5.1.1 Determination of R_z R_z shall be that only the reference length is sampled from the roughness curve in the direction of its mean line, the sum of the average value of absolute values of the heights of five highest profile peaks (Y_p) and the depths of five deepest profile valleys (Y_v) measured in the vertical magnification direction from the mean line of this sampled portion and this sum is expressed in micrometer (µm) (see Fig. 4).

$$R_z = \frac{|Y_{p1} + Y_{p2} + Y_{p3} + Y_{p4} + Y_{p5}| + |Y_{v1} + Y_{v2} + Y_{v3} + Y_{v4} + Y_{v5}|}{5}$$

where, Y_{p1}, Y_{p2}, Y_{p3}, Y_{p4}, Y_{p5} : altitudes of the heights of five highest profile peaks of the sampled portion corresponding to the reference length l

Y_{v1}, Y_{v2}, Y_{v3}, Y_{v4}, Y_{v5} : altitudes of the depths of five deepest profile valleys of the sampled portion corresponding to the reference length l

Fig. 4. Determination of R_z



5.1.2 Reference length The reference length, in the determination of R_z, shall generally be chosen from the following six kinds:

0.08, 0.25, 0.8, 2.5, 8, 25 Unit: mm

5.1.3 Standard values of reference lengths The standard values of the reference lengths and the evaluation lengths corresponding to the range of R_z in the determination of R_z, should conform to the division of Table 5 generally.

Table 5. Standard values of reference lengths and evaluation lengths in determining R_z

Range of R_z (μm)		Reference length l (mm)	Evaluation length l_n (mm)
Exceeding	Max.		
(0.025)	0.10	0.08	0.4
0.10	0.50	0.25	1.25
0.50	10.0	0.8	4
10.0	50.0	2.5	12.5
50.0	200.0	8	40

The value within ( ) is given for informative reference.

Remarks: R_z shall be determined on designating the reference length at first. In the case where the indication and designation of the surface roughness are to be carried out, because it is inconvenient to designate this on all such occasions, the values given in Table 5 should be used generally.

5.2 Expression of R_z

5.2.1 Designation of R_z The designation of R_z shall be as follows:

Ten-point mean roughness ________ μm, Reference length ________ mm, Evaluation length ________ mm

or

________ μmR_z, l ________ mm, l_n ________ mm

Remarks 1. When the values of R_z obtained by using the standard values of reference length shown in Table 5 are within the range shown in Table 5, the designation of reference length may be omitted.

2. When using the evaluation lengths of five times the reference lengths, namely, the standard values of evaluation lengths shown in Table 5, the designation of evaluation length may be omitted.

5.2.2 Preferred number series of R_z In the designation of the surface roughness by R_z, the preferred number series of Table 6 should be used generally.

Table 6. Preferred number series of R_z

Unit: µm

	0.125	1.25	**12.5**	125	1250
	0.160	**1.60**	16.0	160	**1600**
	0.20	2.0	20	**200**	
0.025	0.25	2.5	**25**	250	
0.032	0.32	**3.2**	32	320	
0.040	**0.40**	4.0	40	**400**	
0.050	0.50	5.0	**50**	500	
0.063	0.63	**6.3**	63	630	
0.080	**0.80**	8.0	80	**800**	
0.100	1.00	10.0	**100**	1000	

Remarks: It is preferable to use the number series of common ratio of 2 shown in thick figures.

5.2.3 Sectional designation for R_z When it is required to designate R_z in a certain section, numerical values corresponding to the upper limit (the larger value of the designated values) and the lower limit (the smaller value of the designated values) of that section shall be selected from Table 6 and be stated together.

Example 1. If the standard values for reference length of upper limit and lower limit are equal The sectional designation for the upper limit 6.3 µmR_z and lower limit 1.60 µmR_z shall be designated as (6.3 to 1.60) µmR_z. In this case, 0.8 mm shall be used for the reference length.

Example 2. If the standard values for reference length of upper limit and lower limit are different The sectional designation for the upper limit 12.5 µmR_z and the lower limit 1.60 µmR_z shall be designated as (12.5 to 1.60) µmR_z. In this case, it means that the value of R_z measured in the reference length of 2.5 mm is 12.5 µmR_z or under, and that the value of R_z measured in the reference length of 0.8 mm is 1.60 µmR_z or over.

Remarks 1. If it is required to equalize the reference lengths corresponding to the upper and lower limits or if any reference length other than the standard value of Table 5 is used, the reference length shall be stated together. In Example 2., if the reference length corresponding to the upper and lower limits is to be taken as 2.5 mm, it shall be designated as (12.5 to 1.60) µmR_z, l 2.5 mm.

2. R_z of the upper and lower limits mentioned here shall be an arithmetical mean value of R_z on several places randomly sampled from the designated surface, and shall not be the maximum value of individual R_z.

6. Definition and designation of mean spacing of profile irregularities (S_m)

6.1 Definition of S_m

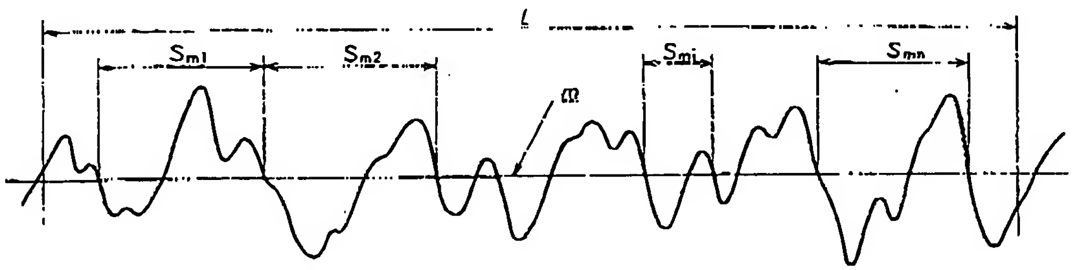
6.1.1 Determination of S_m S_m shall be that the portion equal to the reference length is sampled from the roughness curve in the direction of its mean line, and within this sampled portion, the sum of the lengths of mean lines corresponding to one of the profile peaks and one profile valley adjacent to it (hereafter referred to as "spacing of profile irregularities") is obtained and the arithmetical mean value of many spacings of these irregularities is expressed in millimeter (mm) (see Fig. 5).

$$S_m = \frac{1}{n} \sum_{i=1}^{n} S_{mi}$$

where, S_{mi} : spacing of irregularities

n : number of spacings of irregularity lying within the reference length

Fig. 5. Determination of S_m



6.1.2 Reference length The reference length, in the determination of S_m, shall generally be chosen from the following six kinds:

0.08, 0.25, 0.8, 2.5, 8, 25 Unit: mm

6.1.3 Standard values of reference length The standard values of reference lengths and evaluation lengths corresponding to the range of S_m shall, in general, conform to the division of Table 7.

Table 7. Standard values of reference length and evaluation length in determination of S_m

Range of S_m (mm)		Reference length l (mm)	Evaluation length l_n (mm)
Exceeding	Max.		
0.013	0.04	0.08	0.4
0.04	0.13	0.25	1.25
0.13	0.4	0.8	4
0.4	1.3	2.5	12.5
1.3	4.0	8	40

Remarks: S_m shall be determined upon designating the reference length. In the indication and designation of surface roughness, because it is inconvenient to designate on every occasion, the standard values of reference length and evaluation length given in Table 7 should be used generally.

6.2 Expression of S_m

6.2.1 Designation of S_m The designation of S_m shall be as follows:

Mean spacing of profile irregularities ______ mm, Reference length ______ mm, Evaluation length ______ mm

or

______ mmS_m, l______ mm, l_n ______ mm

Remarks 1. If the value of S_m determined by using the standard value of the reference length shown in Table 7 is within the range shown in Table 7, the designation of reference length may be omitted.

2. When using the evaluation length of five times the reference length, namely, the standard value of the evaluation length given in Table 7, the designation of evaluation length may be omitted.

6.2.2 Preferred number series of S_m In the designation of surface roughness by S_m, the preferred number series in Table 8 should be used generally.

Table 8. Preferred number series of S_m

Unit: mm

	0.0125	0.125	1.25	**12.5**
	0.0160	0.160	**1.60**	
	0.020	**0.20**	2.0	
0.002	**0.025**	0.25	2.5	
0.003	0.032	0.32	**3.2**	
0.004	0.040	**0.40**	4.0	
0.005	**0.050**	0.50	5.0	
0.006	0.063	0.63	**6.3**	
0.008	0.080	**0.80**	8.0	
0.010	**0.100**	1.00	10.0	

Remarks: It is preferable to use the number series of common ratio of 2 shown in thick figures.

6.2.3 Sectional designation for S_m When it is required to designate S_m in a certain section, the numerical values corresponding to the upper limit (the larger value of the designated values) and the lower limit (the smaller value of the designated values) of that section shall be selected from Table 8 and be described together.

Example 1. If the standard values of reference length of upper limit and lower limit are equal The sectional designation for the upper limit of 0.100 mmS_m and the lower limit of 0.050 mmS_m shall be indicated as (0.100 to 0.050) mmS_m. In this case, 0.25 mm shall be used for the reference length.

Example 2. If the standard values of reference length of upper limit and lower limit are different The sectional designation for the upper limit of 0.80 mmS_m and the lower limit of 0.20 mmS_m shall be indicated as (0.80 to 0.20) mmS_m. In this case, it means that the value of S_m measured in the reference length of 2.5 mm is 0.80 mmS_m or under, and that the value of S_m measured in the reference length of 0.8 mm is 0.20 mmS_m or over.

Remarks 1. If it is required to equalize the reference lengths corresponding to the upper and lower limits or if other reference lengths than the standard values shown in Table 7 are used, the reference length shall be described together. In Example 2., if reference length corresponding to the upper and lower limits is taken as 2.5 mm, it shall be designated as (0.80 to 0.20) mmS_m, l 2.5 mm.

2. S_m of the upper and lower limits mentioned here shall be the arithmetical mean value of S_m at several places sampled at random from the designated surface and not be the maximum value of individual S_m.

7. Definition and designation of mean spacing of tops of local peak of profile (S)

7.1 Definition of S

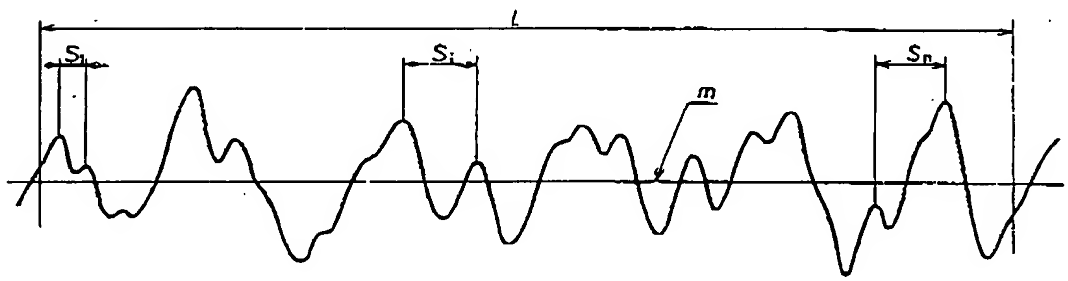
7.1.1 Determination of S S shall be that the portion equal to the reference length is sampled from the roughness curve in the direction of its mean line, and within this sampled portion, the length of mean line corresponding to the spacing between two adjacent tops of local peak of profile (hereafter referred to as "spacing of tops of local peak of profile") is obtained and the arithmetical mean value of spacings between these many tops of local peak of the profile is expressed in millimeter (mm) (see Fig. 6).

$$S = \frac{1}{n} \sum_{i=1}^{n} S_i$$

where, S_i : spacing of tops of local peak of profile

n : number of spacings between tops of local peak of profile within the reference length

Fig. 6. Determination of S



7.1.2 Reference length The reference length, in the determination of S, shall be chosen from the following six kinds in general:

0.08, 0.25, 0.8, 2.5, 8, 25 Unit: mm

7.1.3 Standard values of reference length The standard values of reference lengths and evaluation lengths corresponding to the range of S in the determination of S shall conform to the division given in Table 9.

Table 9. Standard values of reference length and evaluation length in determination of S

Range of S (mm)		Reference length l (mm)	Evaluation length l_n (mm)
Exceeding	Max.		
0.013	0.04	0.08	0.4
0.04	0.13	0.25	1.25
0.13	0.4	0.8	4
0.4	1.3	2.5	12.5
1.3	4.0	8	40

Remarks: S shall be determined upon designating the reference length. In the indication and designation of surface roughness, because it is inconvenient to designate on every occasion, the standard values of reference length and evaluation length shown in Table 9 should be used generally.

7.2 Expression of S

7.2.1 Designation of S The designation of S shall be as follows:

Mean spacing of tops of local peak of profile ______ mm, Reference length ______ mm, Evaluation length ______ mm

or

______ mm$S$, l ______ mm, l_n ______ mm

Remarks 1. If the value of S determined by using the standard value of the reference length shown in Table 9, is in the range shown in Table 9, the designation of reference length may be omitted.

2. When using the evaluation length of five times the reference length, namely, the standard value of evaluation length shown in Table 9, the designation of evaluation length may be omitted.

7.2.2 Preferred number series of S In the designation of surface roughness by S, the preferred number series in Table 10 should be used generally.

Table 10. Preferred number series of S

Unit: mm

	0.0125	0.125	1.25	**12.5**
	0.0160	0.160	**1.60**	
	0.020	**0.20**	2.0	
0.002	**0.025**	0.25	2.5	
0.003	0.032	0.32	**3.2**	
0.004	0.040	**0.40**	4.0	
0.005	**0.050**	0.50	5.0	
0.006	0.063	0.63	**6.3**	
0.008	0.080	**0.80**	8.0	
0.010	**0.100**	1.00	10.0	

Remarks: It is preferable to use the number series of common ratio of 2 indicated by thick figures.

7.2.3 Sectional designation for S When it is required to designate S in a certain section, the numerical values corresponding to the upper limit (the larger value of the designated values) and the lower limit (the smaller value of the designated values) of that section shall be selected from Table 10 and be described together.

Example 1. If the standard values of reference length of upper limit and lower limit are equal The sectional designation for the upper limit of 0.100 mm$S$ and the lower limit of 0.050 mm$S$ shall be indicated as (0.100 to 0.050) mm$S$. In this case, 0.25 mm shall be used for the reference length.

Example 2. If the standard values of reference length of upper limit and lower limit are different The sectional designation for the upper limit of 0.80 mmS and the lower limit of 0.20 mm$S$ shall be indicated as (0.80 to 0.20) mm$S$. In this case, it means that the value of S measured in the reference length of 2.5 mm is 0.80 mm$S$ or under and that the value of S measured in the reference length of 0.8 mm is 0.20 mm$S$ or over.

Remarks 1. If it is required to equalize the reference lengths corresponding to the upper and lower limits or if other reference lengths than the standard values shown in Table 9 are used, the reference length shall be described together. In Example 2., if the reference length corresponding to the upper and lower limits is taken as 2.5 mm, it shall be designated as (0.80 to 0.20) mm$S$, l 2.5 mm.

2. S of the upper and lower limits mentioned here shall be the arithmetical mean value of S at several places sampled at random from the designated surface and not be the maximum value of individual S.

8. Definition and designation of profile bearing length ratio (t_p)

8.1 Definition of t_p

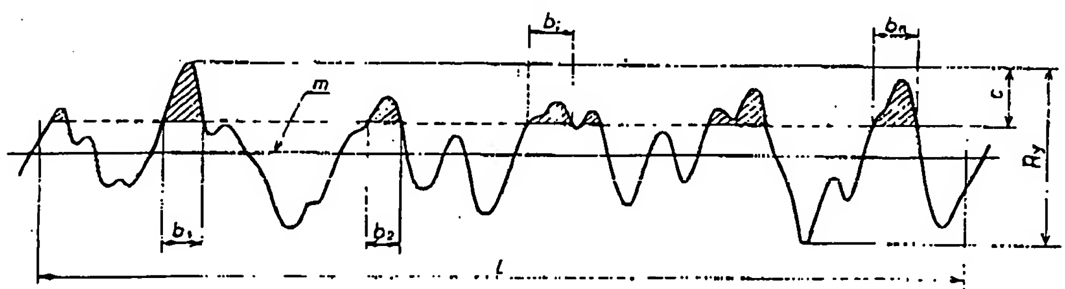
8.1.1 Determination of t_p t_p shall be that the portion equal to the reference length is sampled from the roughness curve in the direction of its mean line and the ratio of the sum of cut lengths obtained at the time of cutting this sampled portion of roughness curve at the cutting levels parallel to the top of profile peak line (profile bearing length, η_p) to the reference length is expressed in percentage (see Fig. 7).

$$t_p = \frac{\eta_p}{l} \times 100$$

where, η_p : $b_1 + b_2 + \cdots + b_n$

l : reference length

Fig. 7. Determination of t_p



8.1.2 Reference length The reference length, in the determination of t_p, shall be selected from the following six kinds in general:

0.08, 0.25, 0.8, 2.5, 8, 25 Unit: mm

8.1.3 Cutting level The cutting level at the time of determining t_p shall be in accordance with any one of the following two methods:

(1) Express with the numerical value in micrometer (μm).

(2) Express its ratio to R_y with percentage (%). The preferred number series to be used in this case is shown below:

5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 75, 80, 90

Remarks: When expressing c with the percentage (%) in accordance with (2), it is necessary to obtain R_y in the first place from the roughness curve in the reference length.

8.2 Expression of t_p

8.2.1 Designation of t_p The designation of t_p shall be as follows:

Profile bearing length ratio ______ %, Cutting level ______ µm, Reference length ______ mm, Evaluation length ______ mm

or

______ % t_p, c ______ µm, l ______ mm, l_n ______ mm

Or

Profile bearing length ratio ______ %, Cutting level ______ %, Reference length ______ mm, Evaluation length ______ mm

or

______ % t_p, c ______ %, l ______ mm, l_n ______ mm

Remarks: To the briefing form for designating the reference length and evaluation length, the case of R_y applies (see Remarks 1. and 2. in 4.2.1).

8.2.2 Preferred number series of t_p When designating the surface roughness by t_p, the preferred number series in Table 11 shall be used in general.

Table 11. Preferred number series of t_p

t_p (%)	10	15	20	25	30	40	50	60	70	80	90

8.2.3 Sectional designation for t_p When it is required to designate t_p in a certain section, the numerical values corresponding to the upper limit (the larger value of the designated values) and the lower limit (the smaller value of the designated values) shall be selected from Table 11 and be described together.

Remarks: For the standard values of reference lengths for the upper limit and lower limit, the values specified in Table 3 at the time of determining R_y shall be used.

Example 1. If the reference length is equal to the standard value In the case of (6.3 to 1.60) µmR_y, 0.8 mm shall be used as the reference length. The sectional designation for the upper limit of t_p of 60 % and the lower limit thereof of 40 % shall be (60 to 40) %t_p, c40%.

Example 2. If the reference length is unequal to the standard length The upper limit and lower limit of t_p shall be described together and the following reference length shall be written additionally:

(60 to 40) %t_p, c40 %, l 2.5 mm

Remarks: t_p of the upper limit and lower limit mentioned here shall be the arithmetical mean value of t_p at several places sampled at random from the designated surface and not be the maximum value of individual t_p.

Annex Definition and designation of center line average roughness

1. Scope This Annex specifies the definition and designation of the center line average roughness (R_{a75}).

Informative reference: The contents of this Annex which are not in conformance with the International standards will be abolished at an appropriate time.

2. Definitions and symbols For the main terms used in this Annex, the following definitions apply:

The symbols for them are shown in ( ), next to the respective terms.

(1) roughness curve for determining R_{a75} (75%) Curve made by extracting the components of surface roughness shorter than a given wavelength on a profile curve by using the high-pass filter of the decay factor of −12 dB/oct [hereafter referred to as "roughness curve (75 %)"].

(2) cut-off value (75 %) of roughness curve (75 %) (λ_{c75}) The wavelength corresponding to the frequency with which the gain of high-pass filter becomes 75 % [hereafter referred to as "cut-off value (75 %)].

(3) mean line of roughness curve (75 %) The straight line or the curve having the geometrical shape of the surface to be measured at the sampled portion of roughness curve (75 %) and the line set so as to make the sum of squares of deviation up to the roughness curve (75 %) minimum.

(4) center line of roughness curve (75 %) The straight line or the curve on the both sides of which the area surrounded by the straight line or the curve parallel to the mean line of roughness curve (75 %) and the roughness curve (75 %) become equal (hereafter referred to as "center line").

3. Definition and designation of center line average roughness (R_{a75})

3.1 Definition of R_{a75}

3.1.1 Determination of R_{a75} R_{a75} is the value obtained by the following formula and expressed in micrometer (μm) under the condition that the portion of measuring length (L) is sampled from the roughness curve (75 %) in the direction of its center line, the center line of the sampled portion is considered as X-axis and the direction of the longitudinal axis as Y-axis, and the roughness curve (75 %) is represented by $y = f(x)$:

$$R_{a75} = \frac{1}{L}\int_0^L |f(x)|dx$$

where, L : measuring length

3.1.2 λ_{c75} λ_{c75} shall be the following six kinds:

0.08, 0.25, 0.8, 2.5, 8, 25 Unit: mm

3.1.3 Standard value of λ_{c75} The standard value of λ_{c75} shall, in general, be in accordance with the division shown in Annex Table 1.

Annex Table 1. Standard value of λ_{c75} in determining of R_{a75}

Range of R_{a75} (μm)		Cut-off value (75 %) λ_{c75} (mm)
Exceeding	Max.	
—	12.5	0.8
12.5	100	2.5

Remarks: R_{a75} shall be determined upon designating λ_{c75} first. When designating or instructing the surface roughness, the values given in Annex Table 1 are used in general, because it is inconvenient to designate them at every time.

3.1.4 Measuring length The measuring length shall be the value not shorter than three times λ_{c75}.

3.2 Expression of R_{a75}

3.2.1 Designation of R_{a75} The designation of R_{a75} shall be as follows:

Center line average roughness (75 %) ______ μm, Cut-off value (75 %) ______ mm, Measuring length ______ mm

or

______ μmR_{a75}, λ_{c75} ______ mm, L ______ mm

Remarks 1. If the value of R_{a75} obtained by using the standard value of λ_{c75} shown in Annex Table 1 lies within the range of Annex Table 1, the designation of λ_{c75} may be omitted.

2. If the measuring length is three times λ_{c75} or longer, the designation of measuring length may be omitted.

3.2.2 Preferred number series of R_{a75} When designating the surface roughness by R_{a75}, the preferred number series in Annex Table 2 should be used generally.

Annex Table 2. Preferred number series of R_{a75}

Unit: µm

0.013	0.4	12.5
0.025	0.8	25
0.05	1.6	50
0.1	3.2	100
0.2	6.3	

3.2.3 Sectional designation for R_{a75} When it is required to designate R_{a75} in a certain section, the numerical values corresponding to the upper limit (the larger value of the designated values) and the lower limit (the smaller value of the designated values) shall be selected from Annex Table 2 and be described together.

Example 1. If the standard values of λ_{c75} at the upper limit and the lower limit are equal The sectional designation for the upper limit of 6.3 µmR_{a75} and the lower limit of 1.6 µmR_{a75} shall be (6.3 to 1.6) µmR_{a75}. In this case, the cut-off value (75 %) of 0.8 mm shall be used.

Example 2. If the standard values of λ_{c75} at the upper limit and the lower limit are different The sectional designation for the upper limit of 25 µmR_{a75} and the lower limit of 6.3 µmR_{a75} shall be (25 to 6.3) µmR_{a75}. In this case, it means that the value of R_{a75} measured with λ_{c75} 2.5 mm is not more than 25 µmR_{a75} and the value of R_{a75} measured with λ_{c75} 0.8 mm is not less than 6.3 µmR_{a75}.

Remarks 1 If it is required to equalize both λ_{c75} corresponding to the upper limit and the lower limit or if the values of λ_{c75} other than the standard values in Annex Table 1 are used, λ_{c75} shall be written together. In Example 2., if λ_{c75} corresponding to the upper limit and the lower limit is 2.5 mm, the designation shall be (25 to 6.3) µmR_{a75}, λ_{c75} 2.5 mm.

2. R_{a75} of the upper limit and lower limit mentioned here shall be the arithmetical mean value of several places sampled at random from the designated surface and not be the maximum value of individual R_{a75}.

Related standards:

JIS B 0031 Technical drawings — Method of indicating surface texture on drawings

JIS B 0610 Definitions and designation of surface waviness

JIS B 0651 Instruments for the measurement of surface roughness by the stylus method

JIS B 0652 Instruments for the measurement of surface roughness by the interferometric method

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